STAR TRANSITS BY PHOTOGRAPHY.[1]

THE annoyance that arises from the effects of a "magnitude equation" in transit observations has led to various suggestions for its detection or removal. Screens in front of the object-glass so as to reduce the light of bright stars have been employed with advantage, and various photographic devices arranged with the view of eliminating personal peculiarities have been adopted. But while ingenuity has been active in proposing practical applications and methods, the numerical results have been few. Recently, Prof. S. Hirayama, of the astronomical observatory at Tokyo, has put in practice a contrivance similar to that employed by the Rev. Father Hagen in photographing a star in the focus of the transit telescope. In this method the exposure and occultation of a star is alternately effected by means of a bar, moved in obedience to a clock, so as to give rise to a series of dots along the star trail.

The Tokyo transit was for this purpose provided with a triple object-glass, reducing the secondary spectrum, and specially corrected for photographic rays. The aperture was 13·5 cm., and the focal length 211 cm. The range of magnitude to which the telescope was applicable depended, of course, upon the time of exposure permitted by the occulting bar. As a matter of fact, with a full second's exposure, equatorial stars of the fifth magnitude gave a measurable image. For stars of greater declination than 73° the exposure of one second was too short to divide distinctly the successive impressions from each other. The limitations of the method are thus clearly indicated. For fainter stars it seems necessary to consider the possibility of moving the photographic plate at the same rate as the star, and imprinting on the plate the image of a fixed reticule at known times. The simpler method adopted by Prof. Hirayama recommended itself to him, since the apparatus could be constructed in the workshops belonging to the observatory.

This apparatus consisted of a camera containing the reticule, occulting bar, and the dark slide, which could be inserted in the place ordinarily occupied by the wires and eye-piece. The reticule consists of seven fine lines ruled upon a microscope cover-glass, firmly cemented to a rectangular frame which carries the dark slide. These lines are interrupted for a short distance in the middle of the field so that they shall not interfere with the star images. The centre of the field is marked by two horizontal wires in the ordinary manner. The occulting bar (Fig. 1) is a thin metal slip about 8 cm. long with a square opening at one end, so as to allow the observer to see the star enter the field, and to permit him to adjust the instrument so that the transit shall take place behind the bar when in its stationary position. The end of this bar is soldered to the armature of an electromagnetic coil. Whenever the electric circuit is established the bar is lifted up and the star exposed. This circuit is made and broken automatically by contact springs in the standard sidereal clock. The bar consequently operates as an exposing shutter, permitting the cone of light from the star to fall for a longer or shorter period upon the sensitised plate, the period being decided by the contact springs.

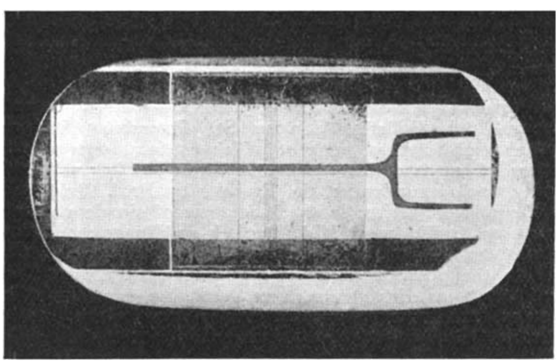

FIG. 1.—Showing the bar at rest, in the centre of the field.

The sensitive plate when inserted in the dark slide comes within 0·2 mm. of the lines of the reticule, so that these lines and the image of the star are practically in the same focus. Evidently this distance must be made as small as possible to reduce any error arising from photographic parallax, but the plate can be shifted in its own plane, so that five separate exposures can be made upon the same plate. The advantage thus secured of taking five stars on the same plate is somewhat discounted by the fact that no proper adjustment can be made for developing the plates according to the different actinic intensity of the stars.

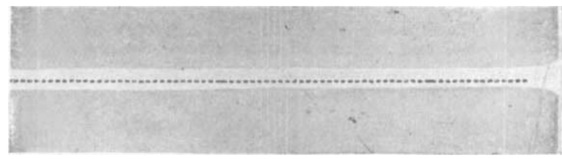

FIG. 2.—The bar removed, showing the transit of a star; slightly enlarged.

The method of observation will be easily apprehended from the description of the apparatus and the character of the results obtained (Fig. 2). The measurement of the plates is not so simple. It is distinctly admitted that to measure a negative is more laborious than to read the fractions of a second from a chronographic sheet. Theoretically, the beginning of each "break" made by the clock is the exact point to which the reading should refer; but owing to the difficulty of measuring the edges of the dots, due to the want of sharp definition, this plan could not be adopted. The middle of the "break" to the middle of the "make" has been taken as the full second. This arrangement, or conventional rule, has probably got over the difficulty arising from the photographic spread, for it seems not impossible but that the want of definition at the edges of the dot, or the distance between two dots, is dependent upon the brightness of the star. But if this source of error is eliminated the author has to regret that the length of the dot depends upon the battery, the spring, the friction, and the moving parts of the apparatus as affected by the variable component of the force of gravity. "The weakening of the battery has been constantly provided for, but at present I see no way of escape from all the other disadvantages."

This admission seems to deprive this peculiar method of observation of much practical benefit. The question that has to be solved is not so much one of relative accuracy as it is of the possibility of eliminating systematic errors, inherent in older and more familiar methods. Looked at as a simple matter of determining the position of a star on a plate at any required moment, the results leave nothing to be desired. In an example worked out in detail it is shown that the error in a single pair of measures is ±0·017s., and the mean error of thirty-two pairs, or what may be regarded as equivalent to a complete transit, ±0·002s. The results of the measures of 140 stars, made when the plate was moved with, and against, the direction of diurnal motion, gave for the average value of personal equation +0·027s., the positive sign implying that the time of transit was longer when the plates were measured along the diurnal motion than when measured against it.

But such measures leave the question of a possible error dependent upon magnitude untouched. Unfortunately, the limited range of magnitude and the small number of observations do not permit any very definite conclusion to be drawn. The author presents a table of forty-six stars in which the photographic magnitude varies from 1·2 mag. to 5·5 mag., and gives residuals for each night and the mean residual. The latter is less than 0·05s. in all but two cases out of the forty-six. Further, when these mean residuals are arranged for each star in the order of photographic magnitude, no relation between the two is notice-

[1] "Preliminary Experiments on the Photographic Transit." By S. Hirayama. Annales de l'Observatoire astronomique de Tokyo. Tome iii., 4e fascicule. (Tokyo, 1905.)

able. Of the two errors greater than 0·05s., one is +0·072s. and the other −0·060s., and the magnitudes of the two stars are the same, and practically in the middle of the series.

But if there is no indication of a "magnitude equation" there is another circumstance which is not a little suspicious, and interesting as suggestive of the introduction of fresh sources of error. The author has referred to the fact that the mean error of observation can become comparatively large when the photographic image is poor, owing to the small altitude of the star. When the residuals are collected according to the zenith distance of the star, there is some indication of a connection between the two. "There is," says Prof. Hirayama, "a common tendency for the residual error to be least at the zenith, and to increase with the zenith distance." No stars below the pole have been observed, so that there is no means of comparing the results given by stars at small altitudes on opposite sides of the zenith. But many important questions are raised in this paper, and we notice with pleasure that Prof. Hirayama proposes to continue the inquiry. We can assure him that his investigations will be watched with interest in this country.

THE MUSEUMS ASSOCIATION.

THE seventeenth annual meeting of the Museums Association was held in Bristol on July 2–5 under the presidency of Dr. W. E. Hoyle, director of the Manchester Museum. The attendance of curators and representatives from various British museums was greater than in any previous year, foreign museums and museum workers being also represented by Geheimrat Dr. A. B. Meyer, of Dresden, Prof. Conwentz, of the Provincial Museum, Dantzig, Prof. Lehmann, of the City Museum, Altona, Mr. H. L. Brakstad, Norwegian Vice-Consul, and others.

The public conference commenced on the morning of July 3 in the Council House, a warm welcome being given to the association on behalf of the city by the Lord Mayor, High Sheriff, and museum committee, after which Dr. Hoyle gave the presidential address, taking as his subject the education of a museum curator. Briefly reviewing the varied training, or lack of training, which many curators have received, Dr. Hoyle divided museums into two great classes:—(*a*) museums of art, or institutions in which objects are regarded simply as material for æsthetic contemplation, where they are arranged so that each may be seen to the best advantage and minister to the cultivated enjoyment of the onlooker; and (*b*) museums of science, in which the object is to exhibit the state of human knowledge on one or more subjects, and to supply means of increasing that knowledge.

Confining his observations to the character of training required for curators of science museums, the president urged the necessity of a fair preliminary training in manual industry and the knowledge and use of tools, and afterwards a technical and scientific training in those subjects underlying the future work of the embryo curator. As subjects necessary to be studied because of their close relation to museum collections were enumerated the natural sciences, mineralogy, geology, biology, including in the latter term botany, zoology, anthropology, and ethnology. As sciences more nearly concerned with the acquisition, registration, preservation and exposition of museum collections were instanced the rudiments of mechanical engineering, physics, and chemistry. As a kind of post-graduate course, the necessity of visiting and studying the nature and methods of work of various museums was strongly insisted upon.

Alderman W. R. Barker, chairman of the Museum and Art Gallery committee, laid before the association a paper he had prepared tracing the rise and progress of the Bristol Museum from its inception in 1808 to the present union of museum and City Art Gallery.

Mr. H. Bolton, curator of the Bristol Museum, followed with a paper describing the general character of the collections, and the steps which had been taken to bring the mode of exhibition and usefulness of the museum contents up to modern requirements, mentioning that it was the intention of the committee to introduce a type-series of mounted specimens, an osteological series, and one in which the main structural features of the animal kingdom would be shown by prepared dissections. Work on similar lines was proceeding in other departments of the museum, and ultimately it was hoped to be able to place at the disposal of any student or visitor all that is necessary in the way of types for the full degree course of any university. Papers were also read by Mr. R. Quick, on the hanging of pictures; by Mr. F. R. Rowley, on a method of displaying coins, and on models of Protozoa; and by Mr. W. W. Watts, on the City plate and insignia.

Wednesday, July 4, was occupied with the discussion of a series of papers on museum cases and fittings, the subject being opened by Dr. A. B. Meyer, of Dresden, who outlined the result of his experiments and researches during the last thirty years upon museum cases. He strongly advocated metal and preferably iron cases, which could be made dust-proof, elegant in appearance, and not more costly than wooden cases. Dr. Meyer's remarks were followed by a paper from Mr. F. A. Lucas, of Brooklyn Museum, and one by Dr. Lehmann on a simple practical dust-proof case in the Altona Museum. Mr. Bantry White, of the Dublin Museum of Science and Art, exhibited an iron museum case built in that museum's own workshops, which was very efficient, dust-proof, and not costly.

A remarkable cabinet case, with changing trays each of which could be brought into view in turn by mechanical means, was exhibited and explained by the Rev. S. J. Ford. Mr. A. M. Rodger exhibited case fittings from the Perth Museum, and Mr. Woolnough, of Ipswich, complete models of cases it was proposed to introduce into the museum at that town. The lighting of museum cases was dealt with by Mr. Thos. White, of London. Dr. F. A. Bather explained the character of some cases in the British Museum, and illustrated his remarks, as did other speakers, by photographs and drawings. Mr. J. Osborne Smith also dealt with the same subject, and exhibited the original drawings and plans of many of the more recently made cases. Owing to the interest and importance of the subject the session was continued in the afternoon until four o'clock.

Thursday was occupied by a paper on the American Museum of Natural History, by Dr. H. C. Bumpus; by a paper on wall diagrams to illustrate prehistoric archæology, from Prof. Conwentz; a paper on the Altona room in the Arts and Crafts Exhibition, Dresden, designed to show how the form of animals is the concrete expression of adaptation to their suroundings; and one on the construction and management of museums of art, by Mr. B. Ives Gilman.

The afternoons and evenings of July 3 and 5 and the whole of Friday, July 6, were occupied by visits to the zoological gardens at Clifton, a conversazione at the Museum and Art Gallery, visits to the stone circles at Stanton Drew, the ancient British lake village near Glastonbury, the Glastonbury Museum, and the Cheddar Gorge and Caves. The meetings were well attended throughout, and a highly successful conference was brought to a close on Saturday last.

THE METEOROLOGY OF THE FREE ATMOSPHERE.

AT the request of the council of the Royal Society of Edinburgh, M. L. Teisserenc de Bort gave an address on the meteorology of the free atmosphere at the meeting of the society on May 21. Subjoined is a summary of his lecture.

The methods for sounding the atmosphere employed at the present day have been in our possession but a few years. The kite, carrying self-registering apparatus, was introduced by the Americans about fifteen years ago; the sounding balloon dates but twelve years back. The use of balloons, furnished with registering apparatus, was proposed by Lemonnier, a French physicist, at the end of the eighteenth century; but they were actually employed for the first time by the Brothers Renard, and especially by MM. Hermite and Besançon, whose first observations go back to 1893.

Observations of great interest had already been made on